

The Use of Discriminatory Function on the Early Expectation of Corporate Financial Bankruptcy: Listed Firms on the Tehran Stock Exchange.

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Abstract

The purpose of this paper is to investigate the accuracy of the discriminant function in the process of predicted financial failure before it occurs. Using the economic definition (profit and loss) and on this basis, the companies have been classified as a failure and Non-failure for three consecutive years. This paper also tries to discover when bankruptcy phenomenon. Therefore, the multi-step analysis was used to achieve this purpose to shed more light on the validity of the discriminant function in the forecasting process with different locations and different economic sectors except for the financial sector the listed firms in Tehran Stock Exchange during 2016-2018 with the companies traded 101 companies classified to 11 failure companies and 90 non-failure companies with 25 ratios listed under the title of liquidity, solvency, activity and profitability, and comparing the results for three years. In the end, this paper found the success of the Discriminant function in predicting financial failure for all years of study, in other markets to predict financial position. The sample belonging to the Tehran Stock Exchange (TSE) showed that the financial ratios affecting the formation of the legal discriminatory function (model) were different from year to year. The final financial position of companies that lost three consecutive years was also explained by comparison with 2019, Bankruptcy phenomenon of 64% of financially failed companies (losers).

Keywords: Failure companies, Non-failure companies, Bankruptcy phenomenon Multiple Discriminant Analysis (MDA), Tehran Stock Exchange (TSE).

1. Introduction

Over the past 53 years, studies have focused on methods that enable analysts and those interested in financial affairs to develop a method that can be used in predicting financial failure or the continuation of companies to carry out their business activities. Statistical methods and financial ratios were used to identify these companies and their financial position and continuity. These studies also confirmed reliable financial ratios in the forecasting process. However, these studies showed that there are specific financial ratios to identify the future financial position (Chada & Hensawang, 2022; Kušter, 2023).

These studies differed on the most successful financial ratios for this purpose. The casting process comes as a result of reaching the facts for a successful investment; the company gives financial strength and supports and maximizes the wealth of these companies through the high prices of shares or demand by interested investors to engage or invest in companies or not. To better manage companies, identify areas of weakness

and take measures that support their departments and their success to shareholders in leading their own companies. Predicting financial position using statistical methods is a handy tool for executives and assists in making timely decisions to avoid future failures that can be relied upon as an early warning system (Ahn et al., 2000; Balcaen, Ooghe, 2006). Forecasting models can also be reached as a basis for auditors whose legal accounts are required by law to identify companies that will continue as functioning and reliable enterprises in the state's national economy.

Multiple Discriminant Analysis (MDA) is a statistical method used to determine group membership based on a set of predictors, (MDA) aims to find a linear set of variables that increase the differences between the studied groups, allowing the items to be sorted into an appropriate group that has the minimum of error(Charles and Brown, 1998). It has been widely used in many fields and on various issues. Multiple discriminatory analysis (MDA) has gained the attention of researchers for predicting financial failure(Altman & Ratios, 1968; Altma et al., 1977; Bhunia & Sarkar, 2011; Chada & Hensawang, 2022). Therefore, it was necessary to simplify the financial statements of companies in the form of financial ratios, short and uniform are dealt with in the search for mathematical equations; to achieve this purpose, this study was studied determine the effective and influential ratios, which amounted to 25 financial ratios of different aspects of activity as independent variables using the statistical method, And the identification of the most appropriate ones. Companies were listed randomly from the Tehran Stock Exchange from different sectors according to their annual profit or loss results for three consecutive years.

This study contributes to achieving the objectives of companies and financial decision-makers, the need for studies in this area helps us to reach scientific and mathematical evidence through which to rely on the early detection of financial failure in companies. Also, it helps evaluate companies' work and solve problems that may occur in the future. The most evidence of increasing interest by researchers and specialists in this area is the state of thumb that companies use in preparing financial statements to mislead or use profit management to manipulate financial statements to improve the company's position. Therefore, to expand the detection of misinformation and the future financial position of companies, researchers seek to find other ways by using financial ratios in the early detection of financial failure and using multiple statistical methods to reach the best.

In this paper, we try to answer the following questions:

- 1- Can MDA be adopted as an early predictor of corporate failure or financial success?
- 2- Are there specific financial ratios adopted by previous studies that could provide a model for financial forecasting for the companies involved in the study?
- 3- Does MDA impact the use of variables (financial ratios) from different sectors?
- 4- Is there homogeneity in the independent variables involved in the composition MDA?
- 5- What is the expected financial position for the new fiscal year (2019) for companies that achieved three consecutive losses in 2016, 2017 and 2018?
- 6- The hypothesis will be built within the practical part that suits this type of studies.

2. Lectures Review

In the scientific literature, scientific articles search for methods of early detection of bankruptcy. All these ideas stem from the principle of maintaining the company's survival. Accounting principles impose the continuity of companies in society, and it is a prerequisite for generally accepted accounting principles. From the early 1960s to the 21st century, multivariate discriminant analysis (MDA) has been the dominant method in predicting bankruptcy modeling (Kušter, 2023).

Studies Altman (1968) was one of the first studies in this field in which the researcher used the statistical method of multi-discriminatory analysis on a group of 32 failed and 32 successful companies and the financial ratios were independent variables. When testing those ratios, the researcher reached a set of percentages of statistical significance; net profit before interest, tax to total assets, the ratio of sales to total assets, the ratio of working capital to total assets, percentage of retained earnings to total assets and market value of shareholders' equity to book value of total liabilities. The model tested the model on a sample of other companies for five years before the failure, reaching 95% accuracy in the first year preceding the financial failure .

Studies Edward B. Deakin (1972) re-examined the Beaver model. This study was in the form of an article in which the researcher used double classification in analyzing 41 financial ratios of the same proportions used by Beaver, where the study was conducted on a sample of 22 successful companies, and 22 failed companies in which Deakin reached similar results. Altman's study was re-applied using discriminant analysis to arrive at the best set of financial ratios that could predict the failure of companies five years before failure. He developed different models in each of the five years before failure. The error rate ranged from 3% to 1.9 in the third, fourth, and fifth years; the error rate was 24% and 11%, respectively. The sample was also tested on another sample of companies, which included 44 failed companies and 23 successful companies. The error rate in the first year was 22%, the second year was 9%, the third was 42%, the fourth was 23%, and the fifth was 49%. The researcher could not justify a large percentage of the error in the first year before the failure occurred.

Once again, Altman et al. (1977) the purpose of the study is to arrive at a model to predict the failure of companies. The researchers divided a sample of 53 working companies and 85 companies that did not work during the period (1969-1975). The researchers used two methods of analysis; the discriminatory analysis and the discriminatory analysis squares. The results suggest that prediction accuracy was in the linear and quadratic model 96.2 in the fifth year before bankruptcy.

Studies by Yap et al. (2010). This study aims to develop a model to improve the predictive ability of the study companies in various financial, commercial and operational conditions in Malaysia. The researcher used 64 companies with 16 financial ratios using multiple discriminant analyses. The results indicate the superiority of seven financial ratios in interpreting the discriminatory function with a high predictive accuracy ranging from 88% to 94% every five years before failure. Endorses the study of Bhunia and Sarkar (2011). Building a model for developing predictive capabilities for corporate bankruptcy in the next stage with different financial, commercial and operational conditions in the Indian context. A total of 64 private sector pharmaceutical companies, with 32 failing companies and 32 successful companies with 16 financial ratios, were analyzed using multiple discriminant analyses. In discriminating power, a vital discriminatory function was established with seven important ratios (WCTA, FFTL, CFTD, TDTA,, RETA, EBIT, and NIS). Classification results showed high predictive accuracy rates ranging from 86% to 96% every five years before failure. Empirical results also reveal that specific liquidity and profitability ratios help predict the success or failure of a company. This study also indicated that the range is reliable and robust, even with the most recent statistical tools.

Maricica and Georgeta (2012) studies aimed to investigate the strength of financial ratios in indicating and distinguishing between operating and non-performing firms on the BSE. The researcher used (t test) on 63 companies and classified them into operating and non-operating companies based on net profit and loss. Negative profits for 2009, and the researcher found differences between companies regarding profitability, return, indebtedness and individual structure two years ago. Regarding cash flows, liquidity, interest

payments and the ability to repay debts did not appear to be very important and were well within the limits of the research. The study recommended deepening this area on a larger scale.

Shyam B. Bhandari (2014) This paper attempts to compare the results of Altman (1968), Bhandari and Ayer (2013). Bhandari's paper is the latest in terms of time. The papers used feature analysis on a sample of failed and unsuccessful companies. Altman's paper focused on general manufacturing using balance sheets and statements of income financial ratios as explanatory variables. Bhandari used a sample of more than 25 industries and used financial ratios based on the three financial statements. Altman came from variables consisting of 22 ratios, and access to five was identified as financial ratios that achieved the highest predictive power. On the other hand, Bhandari's paper used seven financial ratios as rational explanatory variables. This paper compares and critiques the results of the two models.

Ardakani & Mehrjardi (2017) The study aims to develop a bankruptcy model based on three industries: food and beverage, chemical products, automobile manufacturing, and spare parts, using discriminatory analysis techniques. The company's bankruptcy was determined following the 141st standards of the Iranian Commercial Code; The research was conducted from 2001 to 2013, and the results showed good predictive accuracy for all three industries, respectively (91.97.91%).

The study tried Chada & Hensawang (2022) to build a bankruptcy prediction model for real estate companies in Thailand; the study covered the period 2016-2019. The sample included 102 companies registered in the Business Development Department. Twenty-five companies went bankrupt, and 77 did not go bankrupt. Multiple discriminant analysis was used to build the predictive model. The following ratios were obtained, respectively. The financial ratios included (ROA), (ROE), (GPM), (CR), (AT), (OPE), (DA) and (DE). The results of this paper indicate that it is possible to generate warning signals for real estate companies in Thailand with a high accuracy of up to 82.7% when using the appropriate prediction model. The study Kušter (2023) supports a statistical model that can reliably predict the bankruptcy of Serbian Firms one year before bankruptcy proceedings in 100 companies. It was confirmed that the commonly used financial ratios and discriminant analysis could help create a bankruptcy prediction model since of classification the developed model is 71.6% for original grouped cases and 70.3% for cross-validated cases.

The current study attempts to discover the effect of time and space on the financial ratios that can bring about a change in the outputs of the use of the method of discriminatory function in the prediction and where there were new financial ratios to achieve this condition as the previous studies were similar and differed in the influential rates and statistical significance between failed companies. The study also used a sample of different sectors in the Tehran Stock Exchange, excluding financial institutions. It also considered the availability of complete data on the selected sample, which was described as the most significant sample that differed from previous studies over three consecutive years.

3. Research methodology

The sample analysed in this study consists of 101 listed firms on the Tehran Stock Exchange. Our sample firms in the financial sector were excluded for greater unity in the corporate sample. For these companies, financial information was collected from the financial statements for the 2016-2018 list firms Tehran Stock Exchange.

We do not have a legal definition of this paper because it is based on an economic definition of an economic failure that we have relied on (see; Pringle and Harris, 1984, p: 632.633) "Companies' inability to achieve the desired or reasonable return compared to the investment rate or when the capital is negative when the value of the Company's liabilities is greater than the carrying amount of the Company's assets. " Based on

this approach, the information was used from the profit and loss account for 2016-2018 to identify the Failure and Non-Failure companies. These companies were classified into the following categories:

- 1- Failure companies 11 companies;
- 2- Non-Failure companies 90 companies.

The study also considered that many studies considered the principle of profit (negative or positive) as a cup to judge the financial failure or success expected in the future. Based on this principle, the three consecutive years of changes in expectations and their compatibility with the financial situation of the three years were examined. In this paper, we seek to identify the results of companies that have achieved a loss for three consecutive years (2016, 2017 and 2018). These companies continued their financial activity or bankruptcies by comparing them to 2019. To achieve this, we used 25 different ratios, and these variables were introduced into the multi-discrimination analysis of SPSS22.

4. Results Analysis and Evaluation

To test homogeneity of financial ratios and to know which of these latter the ability to distinguish, where the researcher used a step-by-step approach, the results were as follows:

4.1. The test homogeneity

To test homogeneity hypotheses, the following hypotheses were tested:

Hypothesis: When: H_0 is greater than 5%, this implies a homogeneity between the variations of the study variables.

Alternative Hypothesis: When H_1 is less than 5%, the heterogeneity of study variables is not homogeneous.

Table 1. Test homogeneity

Details		2016	2017	2018
Box's M		98.36	332.62	335.65
F	Approx.	14.54	6.30	12.25
	df1	6.00	36.00	21.00
	df2	1701.04	1027.82	1100.51
	Sig.	0.000	0.000	0.000

Tests null hypothesis of equal population covariance matrices (spss22.)

In the table 1. Box's M test results showed that the statistical significance of the test (Sig = 0.000) is less than 0.05. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted. There is no homogeneity between dependent and independent variables.

4.2. The test correlation and explanatory power

The results in Table 2, the correlation test and the explanatory power of Multiple Discriminant Analysis, we conclude:

- 1- Since the variable in our study has only two categories (failed companies and failed companies) and with the column Note Function = 1 this means that we have a single Multiple Discriminant Analysis.
- 2- The value Eigenvalue for three years:-
 - a- 2016 = 1.421.
 - b- 2017 = 3.652.
 - c- 2018 = 5.290.

- d- The greater the intrinsic value, the greater the significance of Multiple Discriminant Analysis (explanatory power). Where this value in 2018 is higher than in 2016 and 2017.
- 3- Canonical Correlation, This value indicates the strength of the relationship, while the square of this correlation indicates the percentage of change in the dependent variable is the financial failure that is marked by the independent variables:
 - a- 2016 = 0.766 and square 59%.
 - b- 2017 = 0.886 and square 79%.
 - c- 2018 = 0.917 and square 84% this value was greater.

Table 2. Eigenvalues

Year	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
2016	1	1.421 ^a	100.0	100.0	.766
2017	1	3.651 ^a	100.0	100.0	.886
2018	1	5.290 ^a	100.0	100.0	.917

- a. First 1 canonical discriminant functions were used in the analysis. (spss22)

To evaluate the differences between the two groups in this study, the financial ratios based on Wilks' Lambda and the following assumptions:

- 1- Hypothesis: When H_0 is greater than (0.05), which indicates no differences between the two groups.
- 2- Alternative hypothesis: when H_1 is less than (0.05) which indicate differences between the two groups.

For the above test hypothesis, the results indicate the following:

Table 3. Wilks' Lambda

Year	Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
2016	1	.413	86.214	3	0.000
2017	1	.215	146.030	8	0.000
2018	1	.159	176.544	6	0.000

In this Table 3, we note that the value of Sig = 0.000 is less than (0.05); this means rejecting the null hypothesis and accepting the alternative hypothesis that there are differences between the two groups derived from the proposed group from financial ratios.

4.3. Function Discriminant Canonique

We are formulating the legal discriminator function for three years as in the following table:

Table 4: Canonical Multiple Discriminant Analysis Coefficients

NO.	Cod	Variables	Function		
			2016	2017	2018
1	X3	Profit margin of sales Ratio	-.035		-0.053
2	X1	Net Profit Ratio	.037	-0.034	
3	X2	Earnings before Interest and taxes	.062	-.075	.064
4	X4	Return on Assets		-0.0005	
5	X18	Debt Ratio		2.3543	
6	X12	Cash flow ratio		1.811	-1.601

7	X15	Inventory Turnover		0.002	-0.001
8	X5	Return on equity		0.052	0.004
9	X23	Equity to Total Assets Ratio			0.056
Constant			-0.545	-1.865	-0.865

The results were collected by the researcher based on spss 22

In the Table 4, we find that the third column gives the variables in the function configuration. The function column gives the parameters of each variable. These parameters are used to construct the function which can be used to classify at specific levels of the independent variables listed in the function.

Accordingly, the legal discrimination function can be constructed for three years as follows:

$$\text{YEAR2016, } Z = -0.545 + (-0.035X3) + (-0.037X1) + (0.062X1).$$

$$\text{YEAR2017, } Z = -1.865 + (-0.034X1) + (-0.075X2) + (0.0005X4) + 2.3543X18 + 1.811X12 + 0.002X15 + 0.0052X5.$$

$$\text{YEAR 2018, } Z = -0.865 + (-0.053X3) + 0.064X2 + (-1.601X12) + (-0.001X15) + 0.04X5 + 0.056X23.$$

The homogeneity indicates in this paper that the financial ratios are very similar. The effect of these ratios is not on the success of The Discriminant function in predicting the financial position of companies. So, through the above table1, we try to formulate the following hypothesis:

H₀: The financial ratios that influence forecasting the financial position are homogenous and consistent from year to year.

H₁: The financial ratios that affect the process of forecasting the financial position are not homogenous and are not identical from year to year.

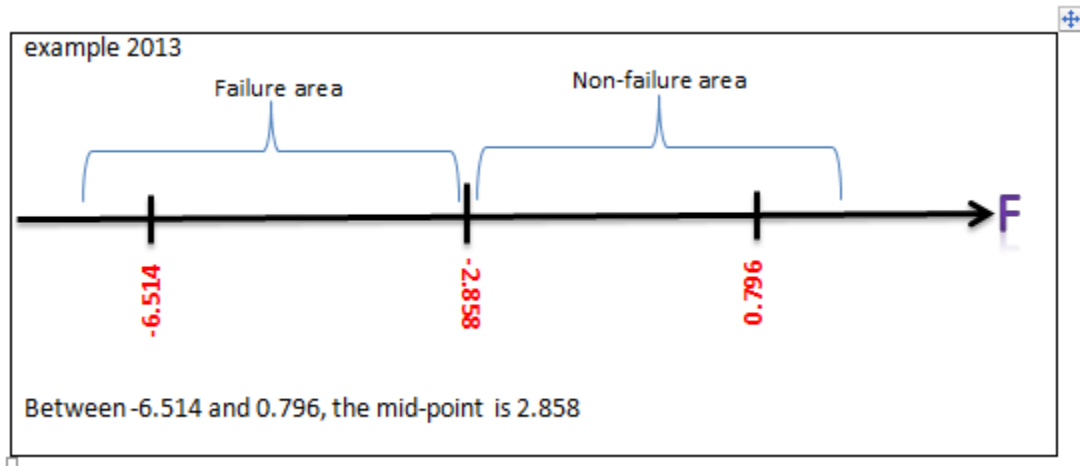
We note differences in the financial ratios for the three years. This difference shows the difficulty of judging the financial ratios specified in forecasting companies' financial position. This paper explains the different independent variables (financial ratios) from year to year respectively (3, 8 and 6). So the effect of different sectors in determining the most influential financial ratios that are homogeneous from year to year in this paper. 3.2.4. Functions at Group Centroids

This table 5. is essential to know the behavior and direction of the expected discriminant function. The midpoint and the discriminant outcome (the failure area and non-failure) show the expected financial position of the companies. Accordingly, We classify the financial position of the companies in the sample from the following test:

Table 5. Functions at Group Centroids

Financial position	2016	2017	2018
	Function	Function	Function
Loss	-3.376	5.411	-6.514
Profit	.413	-.661	.796
med-point	-1.481692509	2.374992943	-2.858739974
non-failure area (profit)	(1.4817) to more than 0.413	2.374 to more than (0.661)	(2.858) to more than 0.796
failure area (loss)	(1.4817) to more than (3.376)	2.374 to more than 5.411	(2.858) to more than (6.514)

figure 1 illustrates the approach for 2013.



4.4. Classification Results

The classification results indicate the quality of the prediction of the group membership using discriminatory analysis. For knowledge of the cases Categorized Correctly, the results show the following table for the years of study:

Table 6. Classification Results ^{a,c}

financial position			Predicted Group Membership		Predicted Group Membership		Predicted Group Membership	
			2016		2017		2018	
			loss	Profit	loss	profit	loss	profit
Original	Count	loss	10	1	10	1	10	1
		profit	0	90	0	90	0	90
	%	loss	90.9	9.1	90.9	9.1	90.9	9.1
		profit	0.0	100.0	0.0	100.0	0.0	100.0
Cross-validated ^b	Count	loss	9	2	10	1	9	2
		profit	0	90	0	90	0	90
	%	loss	81.8	18.2	90.9	9.1	81.8	18.2
		profit	0.0	100.0	0.0	100.0	0.0	100.0
a. original grouped cases correctly classified of :			99%		99%		99%	
b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases of other than that case.								
c. cross-validated grouped cases correctly classified of:			98%		99%		98%	

The results of the classification indicate the quality of the prediction of the membership of the group using the analysis of discrimination, and to know cases categorized correctly explain the results of the above table for the following years of the study:

- 1- The column (loss) predicted group membership. The number of (failed companies) for the three consecutive years (9, 10, and 9) companies, where the classification rate reached (81.8%, 90.9% and 81.8%) and classified correctly.

- 2- Column (profit) predicted group membership. The number of members of companies failed for three consecutive years (90.9090) companies, where the classification rate to (100%, 100%, and 100%) and classified correctly.
- 3- The total number of 101 companies rated correctly, the total quality of the classification for the three years.

Therefore, the total company is 111 companies correctly, with the overall rating quality for the three consecutive years (98%, 99%, and 89%).

4.5. Other results

This paper seeks to identify the companies that have made a loss during the last three years and their financial position in 2019 as in the following table:

Table 7. A summary of the investigations

Details	Sample size	Losing companies 2019	Profit Companies 2019	Bankrupt companies 2019	Percentage of bankrupt companies
Failure companies	11	3	1	7	64%
Non-Failure companies	90	0	90	0	0
Total	101	3	91	7	7%

Table 8. Percentage of bankrupt companies

The actual financial position	2019
Losing companies for the fourth time	3
Winning Companies	1
Bankrupt companies	7
Total Companies	11
Percentage of bankrupt companies	64%

In Table 8, we try to answer the following question:

- 1- What will happen to companies that achieve three successive losses in the past compared to the next year?
- 2- What percentage of continuation, bankruptcy, loss, or profit?

The table above shows the percentage of failed companies, where the first column refers to the actual financial position. The second column refers to the results achieved compared to 2019 as follows:

- 1- The second row of the table shows companies that lost for the fourth time in a row, reaching three companies.
- 2- The third row of the table indicates the companies that made a profit for the fourth time and the number of one company.
- 3- The fourth row of the table indicates companies that went bankrupt in 2019 where the number of seven companies.
- 4- The fifth row of the table refers to the total number of companies.

- 5- The sixth grade of the table refers to the ratio of bankrupt companies to the total, which amounted to 64%.

The researcher predicts that companies that achieve three consecutive losses can be bankrupt by 64%. The advantage of the discriminant function can be used when a new financial year is expected so that this company can reach bankruptcy according to the above ratio.

4. Conclusion

The study included identifying the effects of ratios on the financial status of the institution, which included 101 companies from different sectors traded on the Tehran Stock Exchange (TSE) for the years 2016 to 2018. The distinctive analysis is also used through 25 ratios classified under Profit / Loss, Liquidity, Operating Ratio, and Profitability. So, we study what happens when referring to the results achieved compared to 2019.

- 1- To reach a model with a discriminatory capacity above the percentage of health.
- 2- The results showed that the distinctive function still achieved high predictive ability in the three years of study.
- 3- The results show different sectors where independent variables were interpreted were not identified in the three years.
- 4- The results showed that the independent variable (EBITDA) was achieved over the years of study.
- 5- Comparison of the results for the three years with the variables reached in The discriminant function; the variables were not homogeneous in the three years to some extent. Where in the first three years ratios in the second year eight financial ratios, and the third year were six financial ratios.
- 6- As in the previous studies, it was expected that in the previous three years, specific percentages would not be present. This study did not show this belief. Therefore, in the assessment process, the previous year was used to predict the use of the differential analysis and the adoption of significant financial ratios in The Discriminant function.
- 7- The study showed that companies that achieve three consecutive losses are expected to be bankrupt at 64% in the fourth year.
- 8- Develop electronic programs that include the most important financial ratios that can predict the financial position of companies, to help the management of companies to perform the treatments before a reasonable period.

The determinants of the study can be described as stepping down differently from future studies in the Iranian capital market. Despite the constraints faced by researchers in data collection and the small number of losing companies, the results cannot be generalized in this case; this does not mean stopping research on the phenomena of bankruptcy and financial deficit, but we think it is necessary in the next stage to use a large group of companies, especially companies that suffer a successive loss For three years, taking into account the statistical tests available in this study to reach statistically valid results. In the future, some of these lessons could be provided to fill existing gaps;

- 1- The impact of financial ratios in different sectors on the governance of the financial position of companies.
- 2- The quality of The Discriminant function in predicting the financial position.

Comparing the financial ratios of companies with the sector ratios set (regardless of profit and loss) and considering the sector ratios as the basis for assessing the financial failure of companies by using The Discriminant function.

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